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EUV lithography:

**NXE:3100 is in use at customer sites and
building of NXE:3300B has started**

Rudy Peeters

EUVL October 2011

Progress with respect to the conference last year

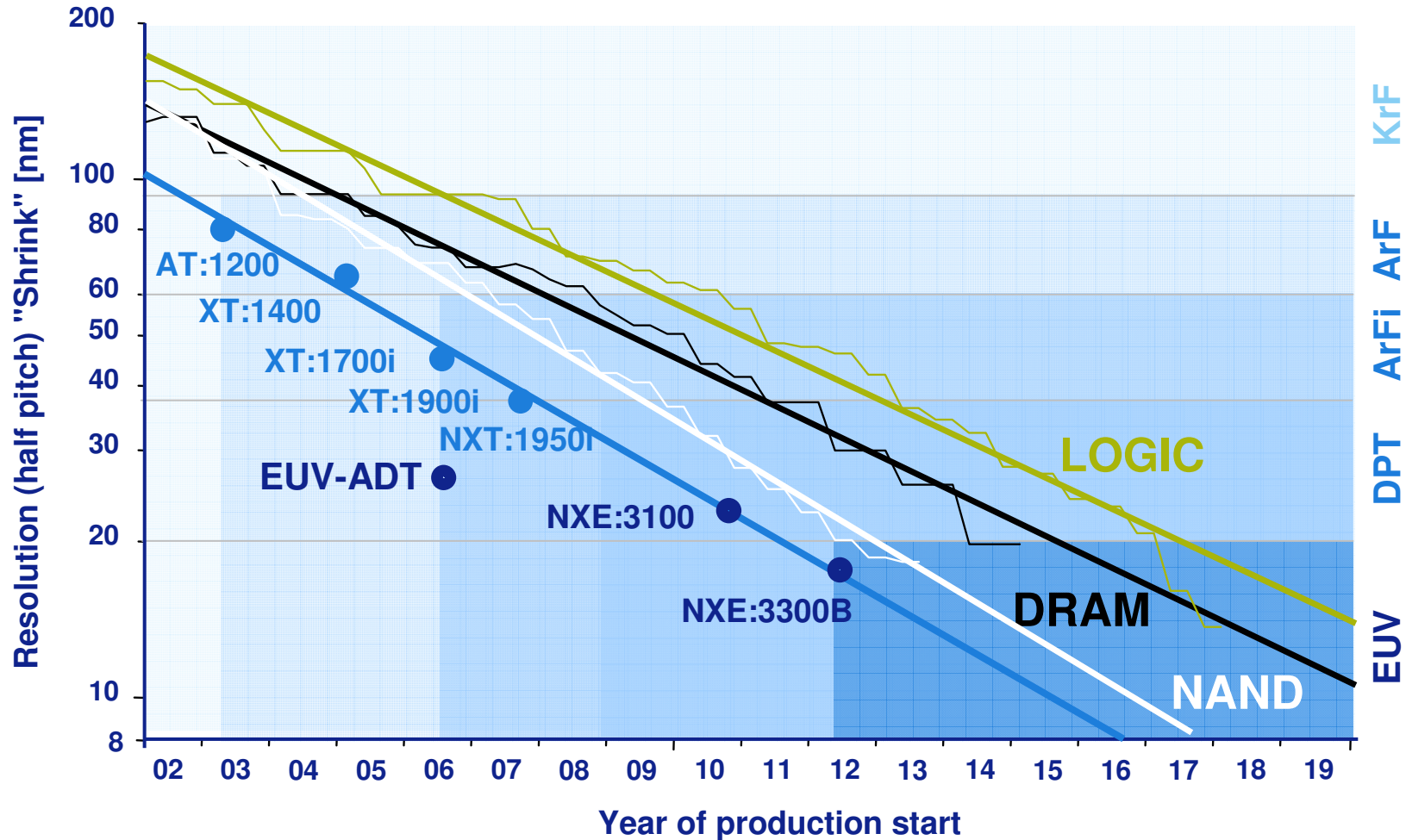
- NXE:3100:
 - achieved six shipments
 - complete imaging data set for all device applications and sub-20nm resolution
 - overlay capability of <1nm shown
 - now sources integrated and used for wafer exposures at customer sites
- NXE:3300B:
 - body fully integrated and under vacuum

Content

- **EUV Roadmap**
- NXE:3100
 - Imaging
 - Overlay
 - Source
- NXE:3300B and EUV extension



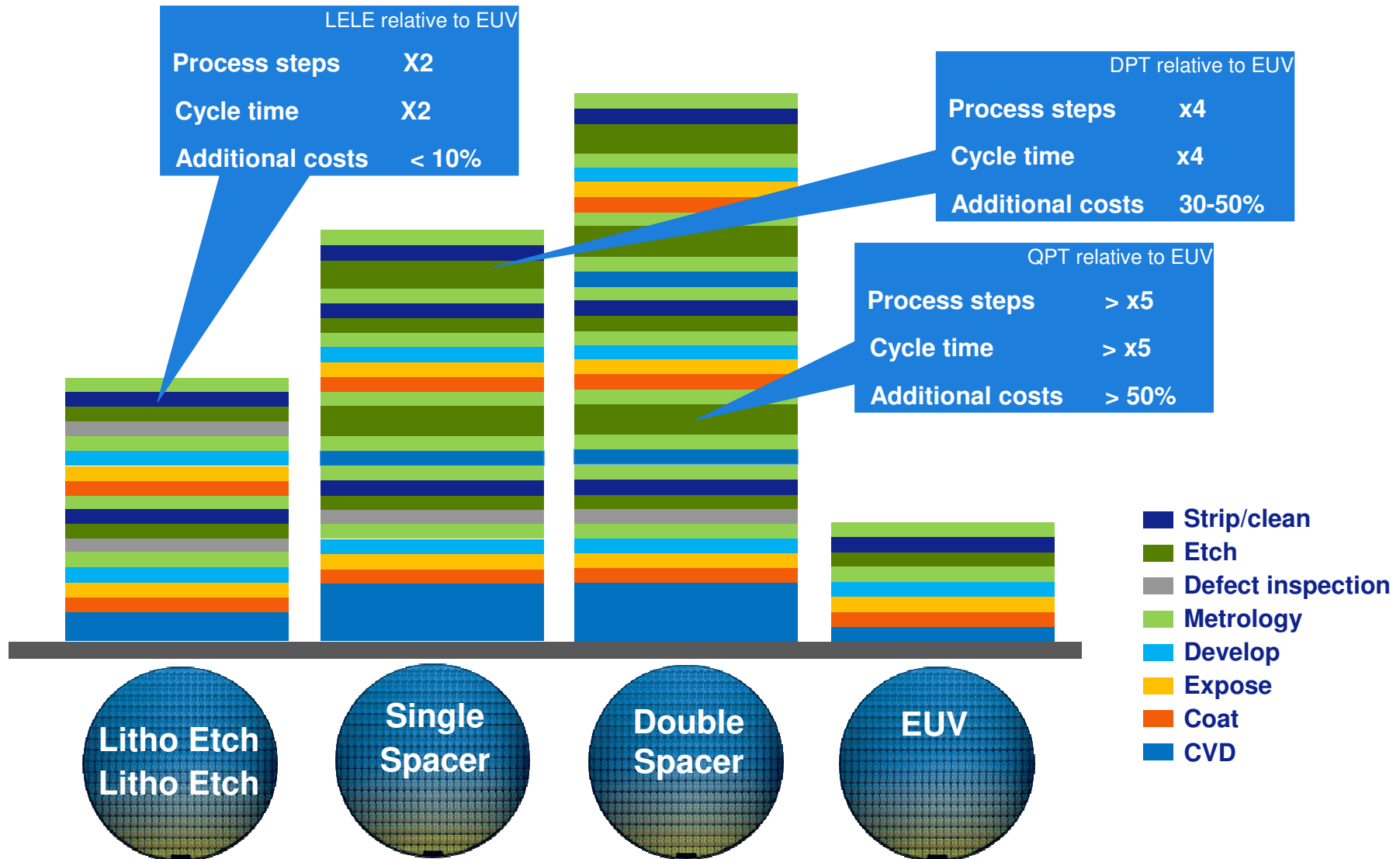
Industry roadmap towards < 10 nm resolution



Notes:

1. R&D solution required 1.5~ 2 yrs ahead of Production
2. EUV resolution requires 7nm diffusion length resist

EUV simplifies process and reduces cost



Data is based on Customer interaction

Slide 5 | Public



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ASML EUV Product Roadmap

	2006 Proto System	2011 NXE:3100	2012 NXE:3300B	2013 NXE:3300C
Resolution	32 nm	27 nm	22 nm	18/16* nm
NA / σ	0.25 / 0.5	0.25 / 0.8	0.33 / 0.2-0.9	0.33 / OAI
Overlay (DCO/MMO)	< 7 nm	< 4/7 nm	< 3/5 nm	< 2.5/4.5 nm
Throughput W/hr	4 W/hr	60 W/hr	125 W/hr	150 W/hr
Dose	5 mJ/cm ²	10 mJ/cm ²	15 mJ/cm ²	15 mJ/cm ²

Main improvements
 1) New EUV platform: NXE
 2) Improved low flare optics
 3) New high sigma illuminator
 4) New high power source
 5) Dual stages

Main improvements
 1) New high NA 6 mirror lens
 2) New high efficiency illuminator
 3) Off-axis illumination option
 4) Source power increase
 5) Reduced footprint

Platform enhancements
 1) Off-Axis illumination
 2) Source power increase

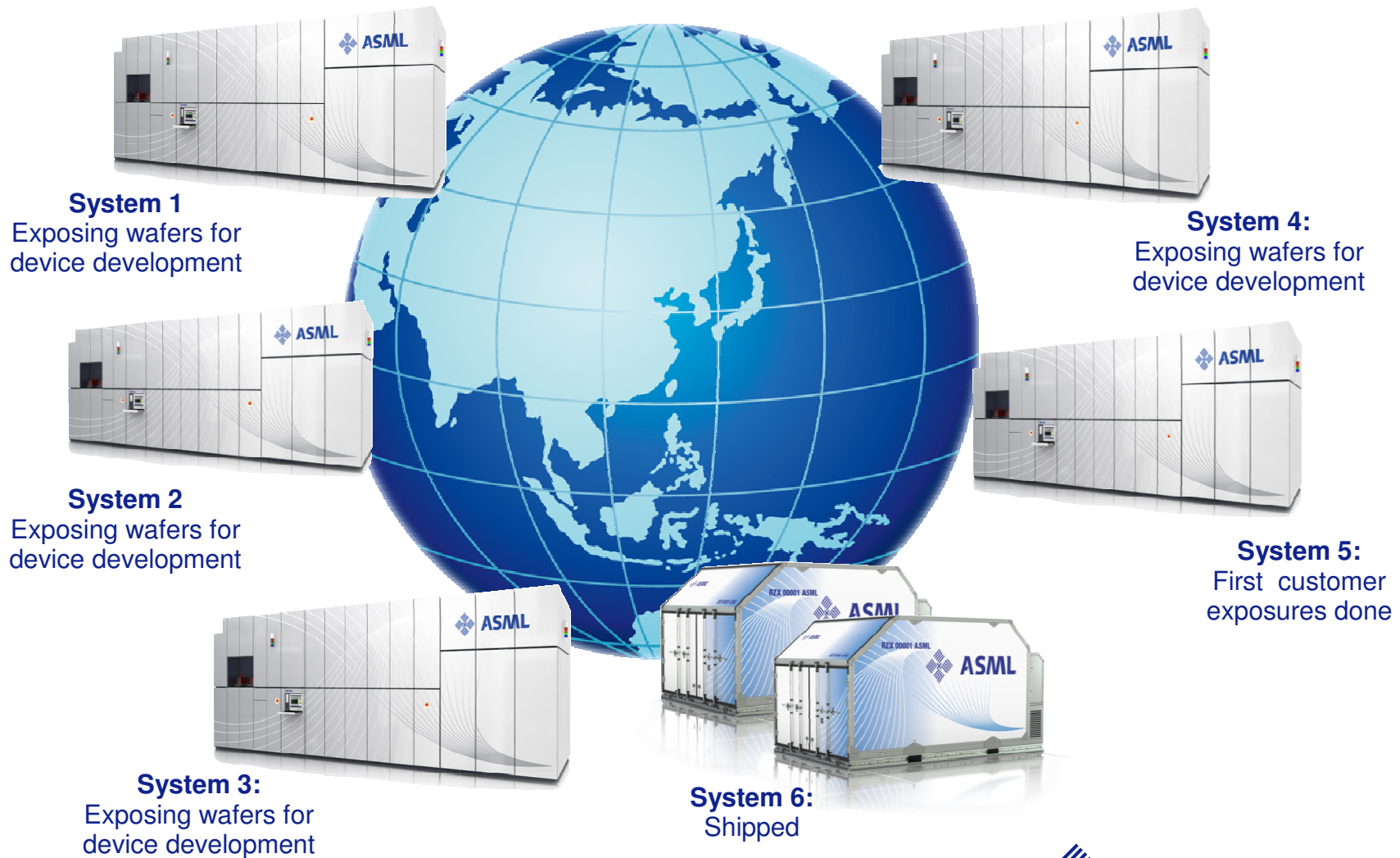
* Requires <7 nm resist diffusion length

Content

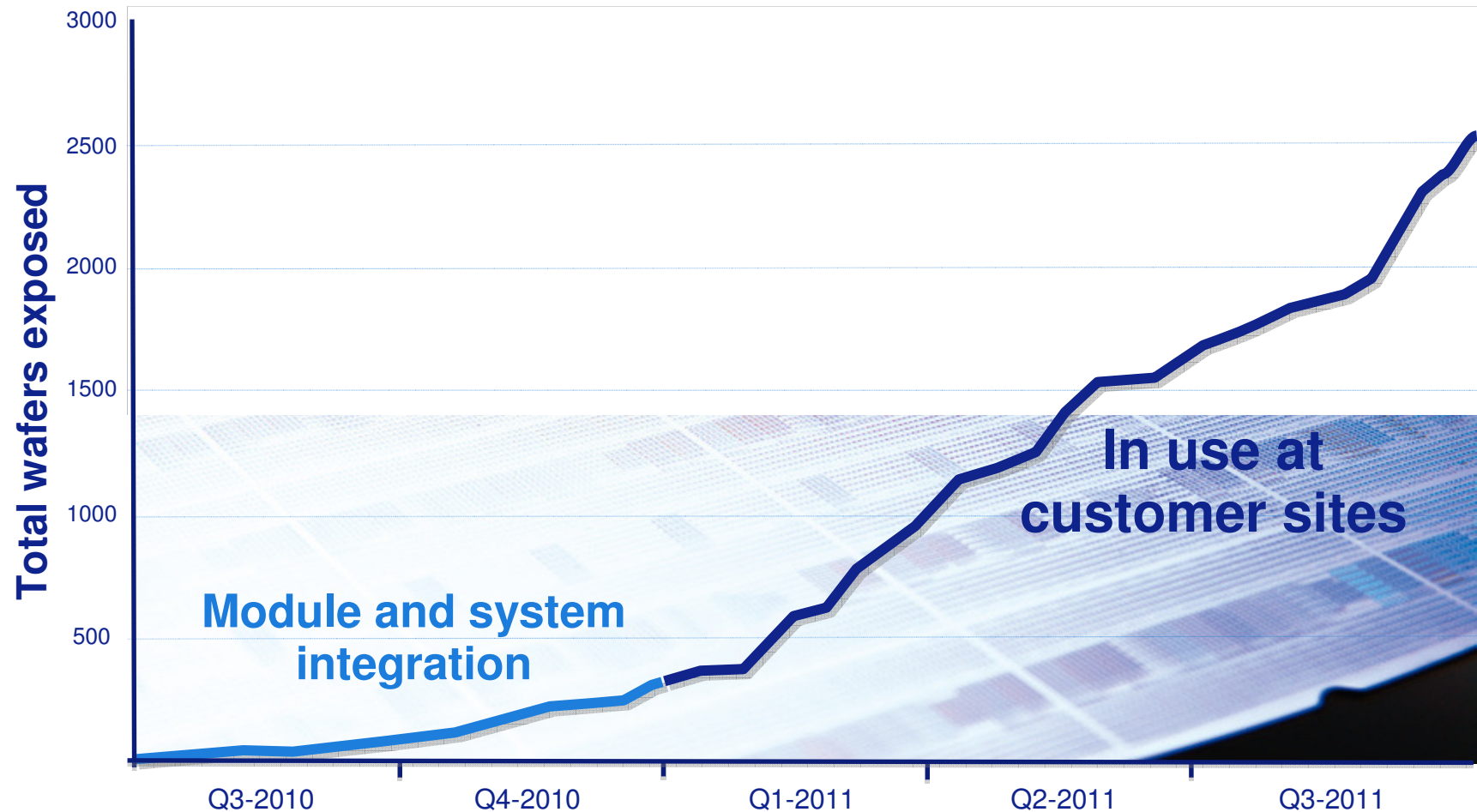
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EUV has arrived worldwide in fabs



The NXE:3100 has exposed more than 2500 wafers and is enabling device development at customer sites



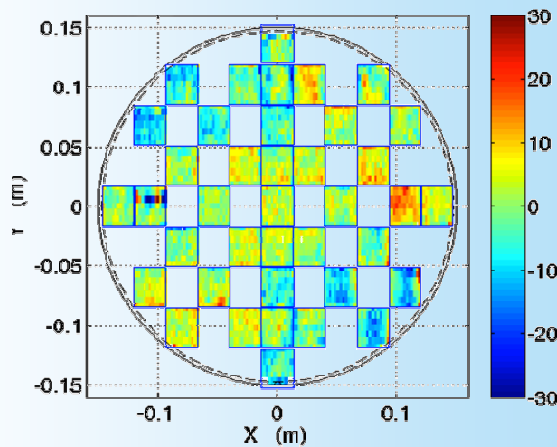
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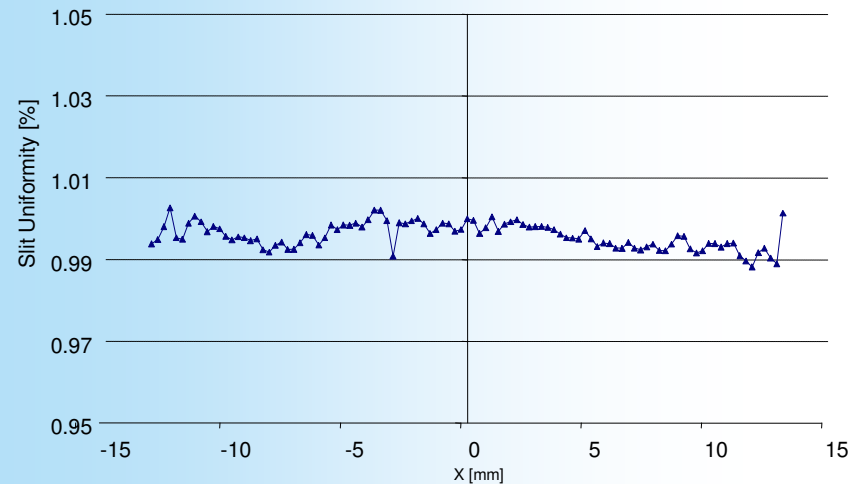


NXE:3100 sub-system performance meets design targets and supports sub-27 nm imaging

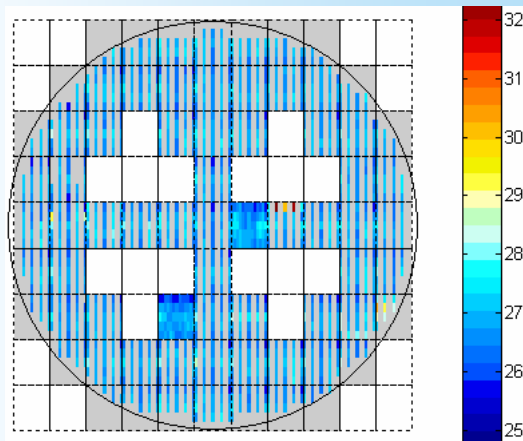
Focus Uniformity: 22.3 nm



Slit Uniformity: 0.7%



Full wafer CDU: 1.4nm



Stable dose control performance

Before improvement (Q2'11)

Wafer	1	2	3	4
% of dies <1% dose control	90%	0%	80%	60%

After improvement (now)

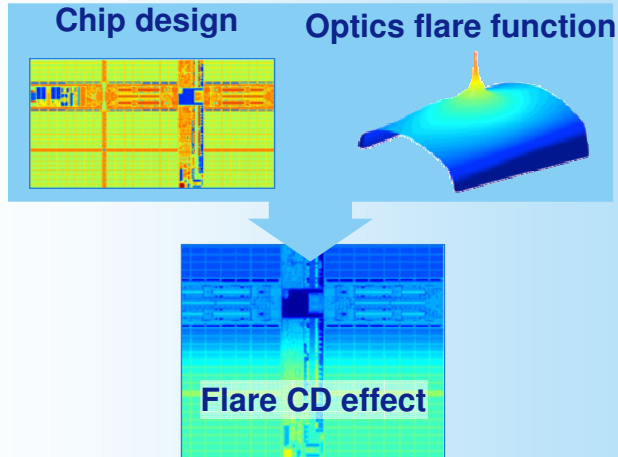
Wafer	1	2	3	4
% of dies <1% dose control	100%	100%	99%	100%



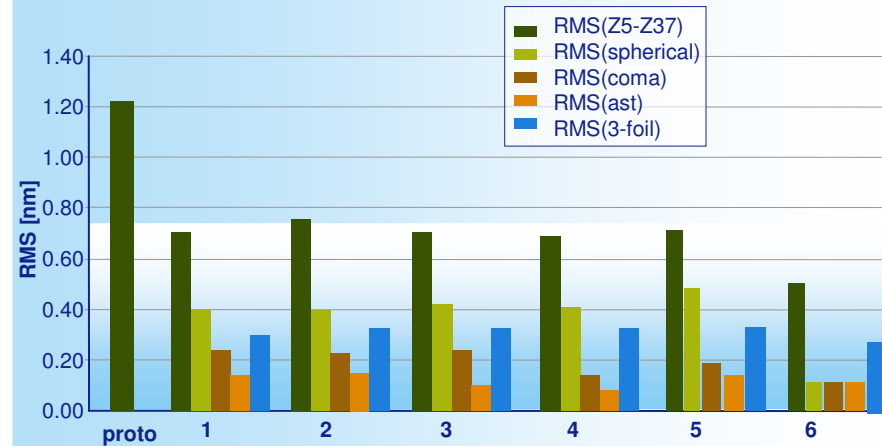
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Computational lithography ready to further improve EUV process window Tachyon NXE

Flare analysis

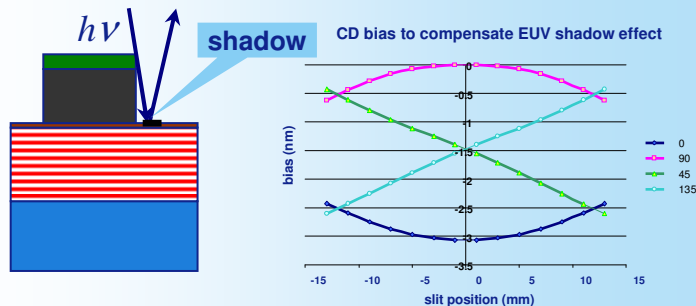


Scanner optics: measured data for model input

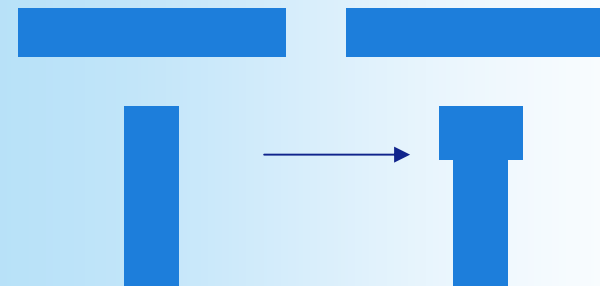


Optics aberration performance

Mask shadowing compensation



Proximity effect compensation



Tachyon model can predict Flare

Flare profile induced on mask for model verification

Through scan flare

Maximum

Range

Proto/ADT

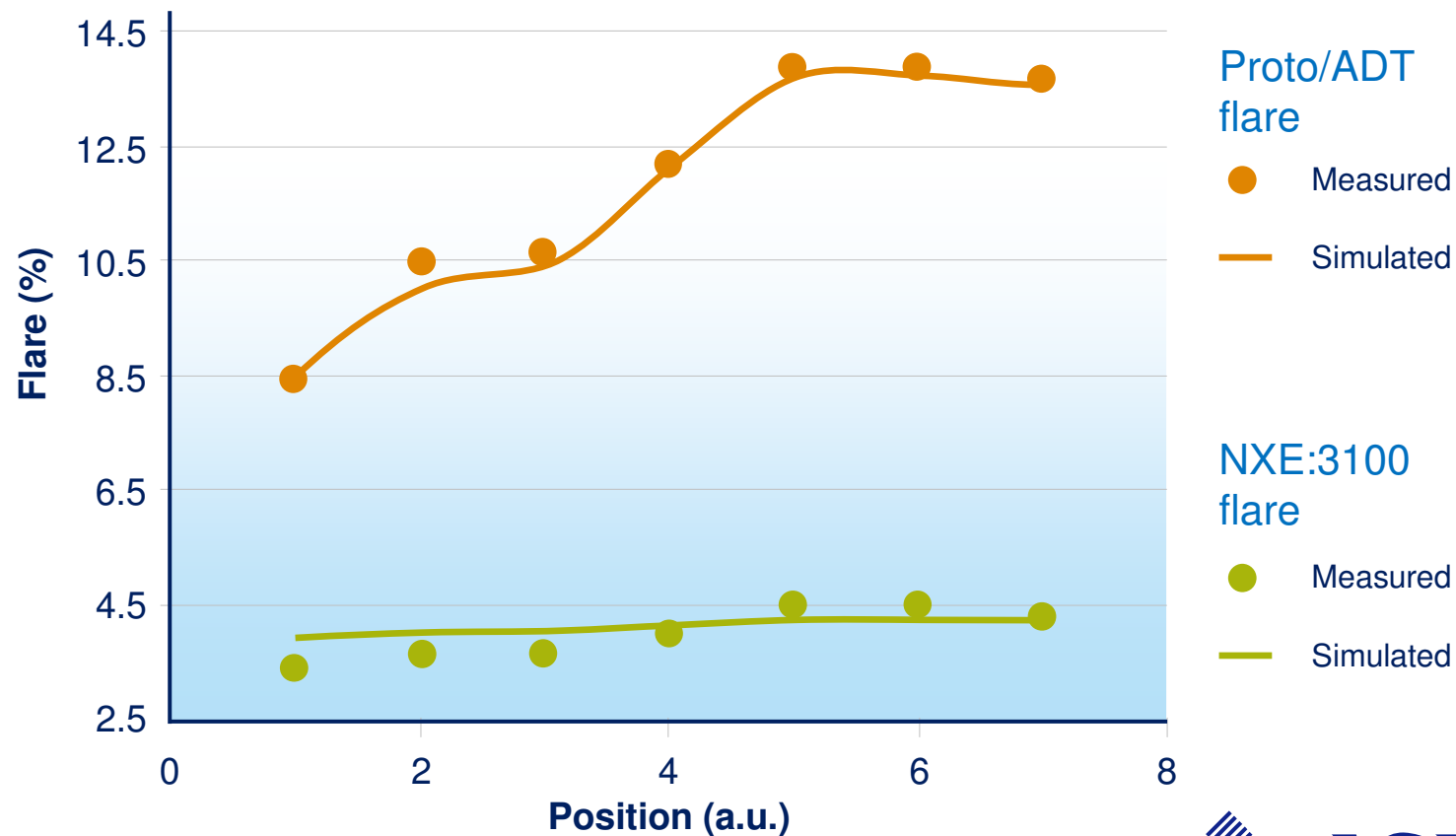
<15%

~ 6%

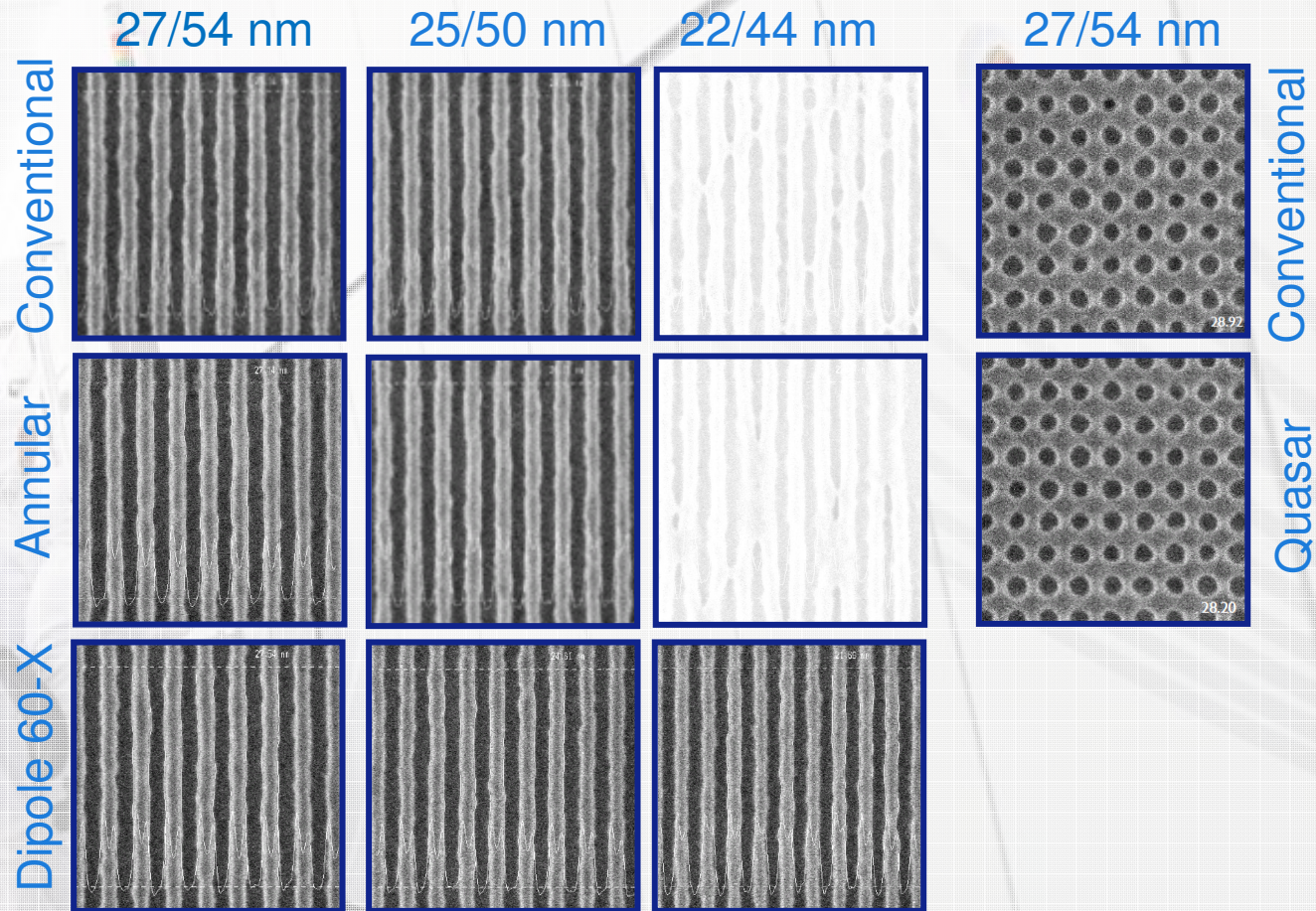
NXE:3100

< 5%

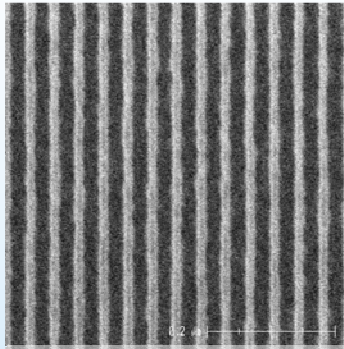
~ 2%



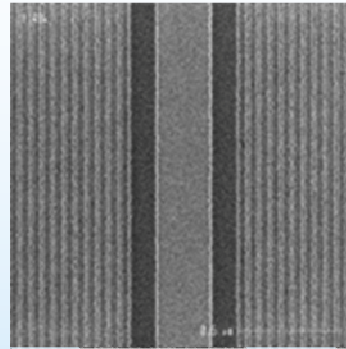
Good Resolution of 22 nm Dense Lines and 27 nm Contact Holes



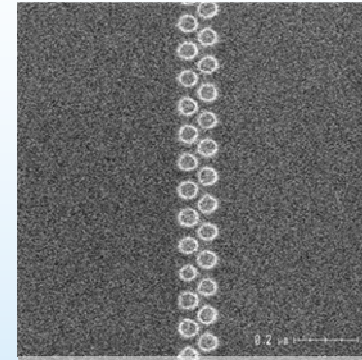
NXE:3100 imaging performance proven for customer use cases



19 nm dense lines

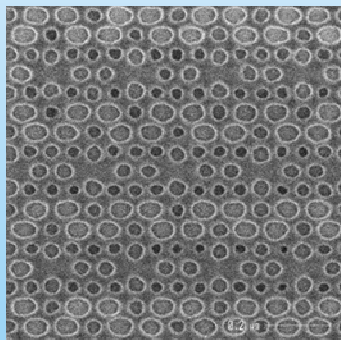


27 nm Gate Layer Flash



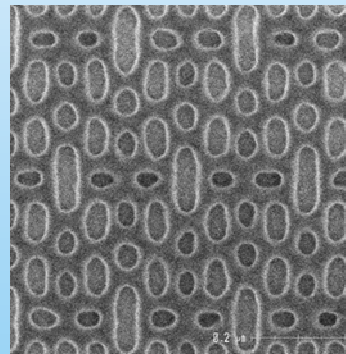
Flash staggered contact layer

Bitline pitch = 44 nm (1:1.2)
CH pitch = 74.4 nm



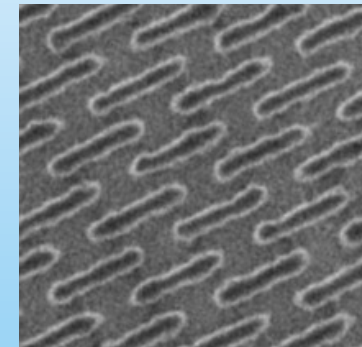
**Sub 16 nm node
SRAM Contact Hole**

0.038 μ m² bit cell-size,
hp 30/32 nm



**Sub 16 nm node
SRAM metal-1**

0.038 μ m² bit cell-size,
hp 30/32 nm



30 nm Brickwall DRAM

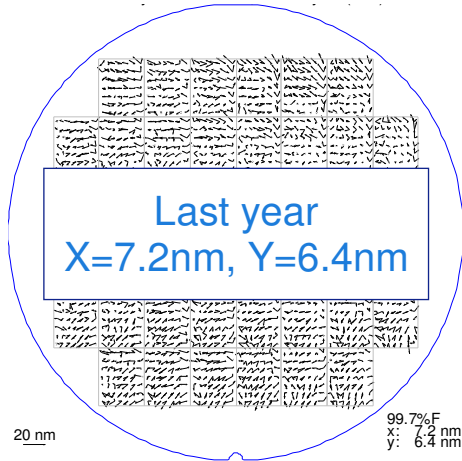


Content

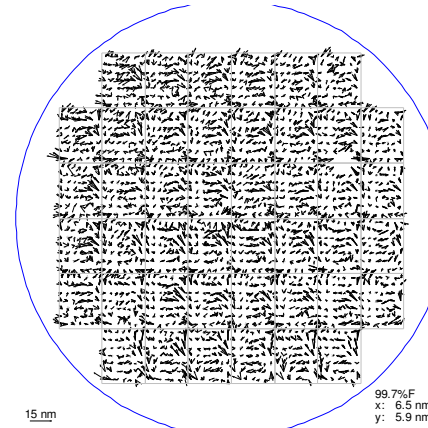
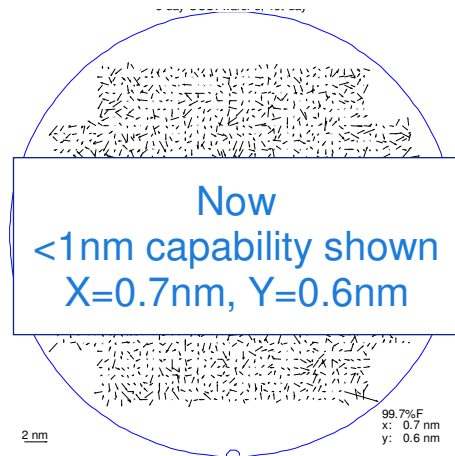
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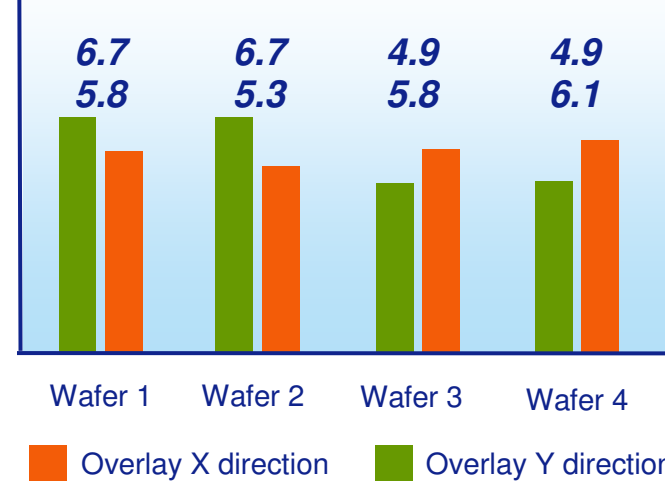
NXE:3100 overlay ready to support process development



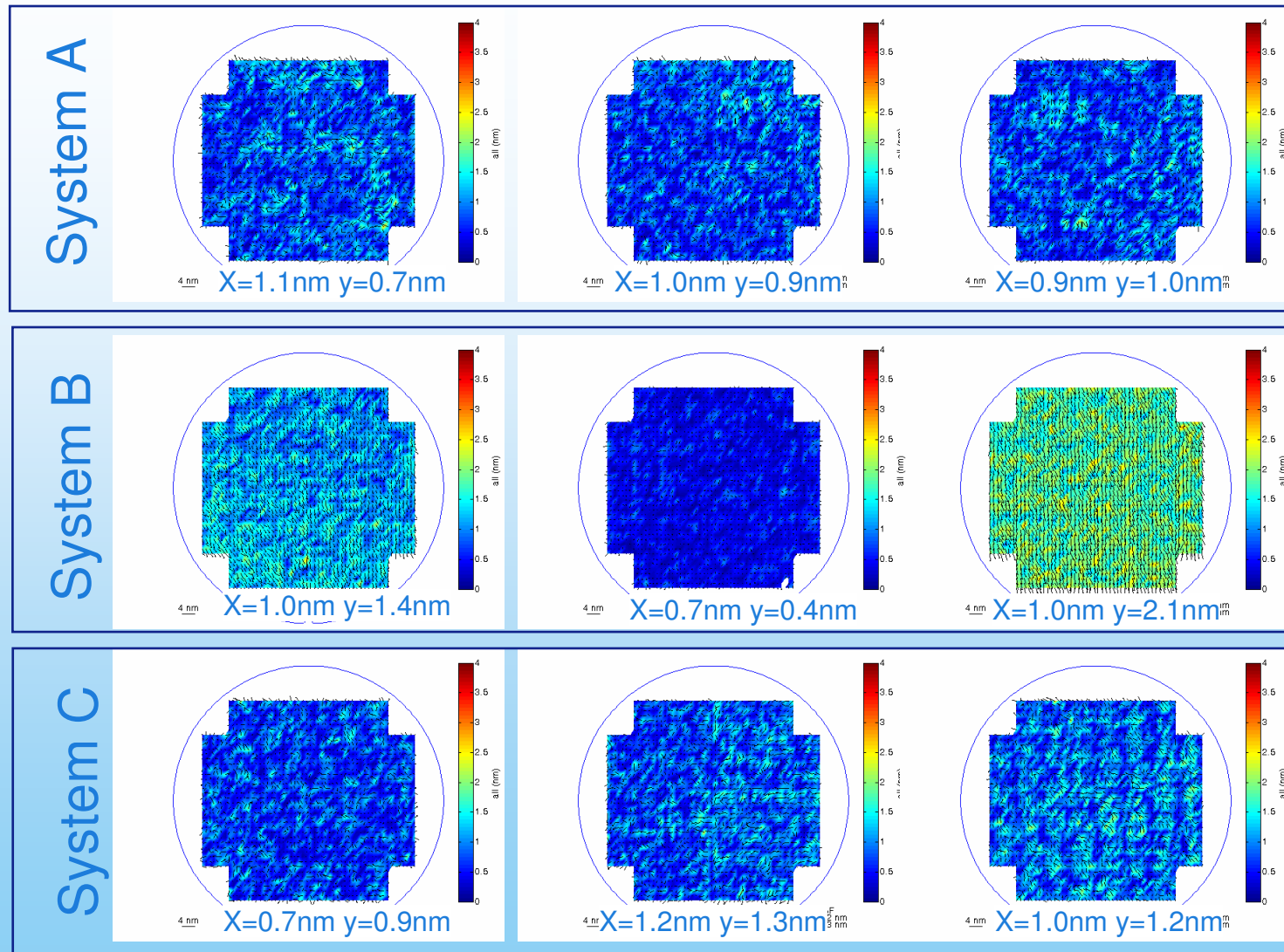
Dedicated Chuck Overlay



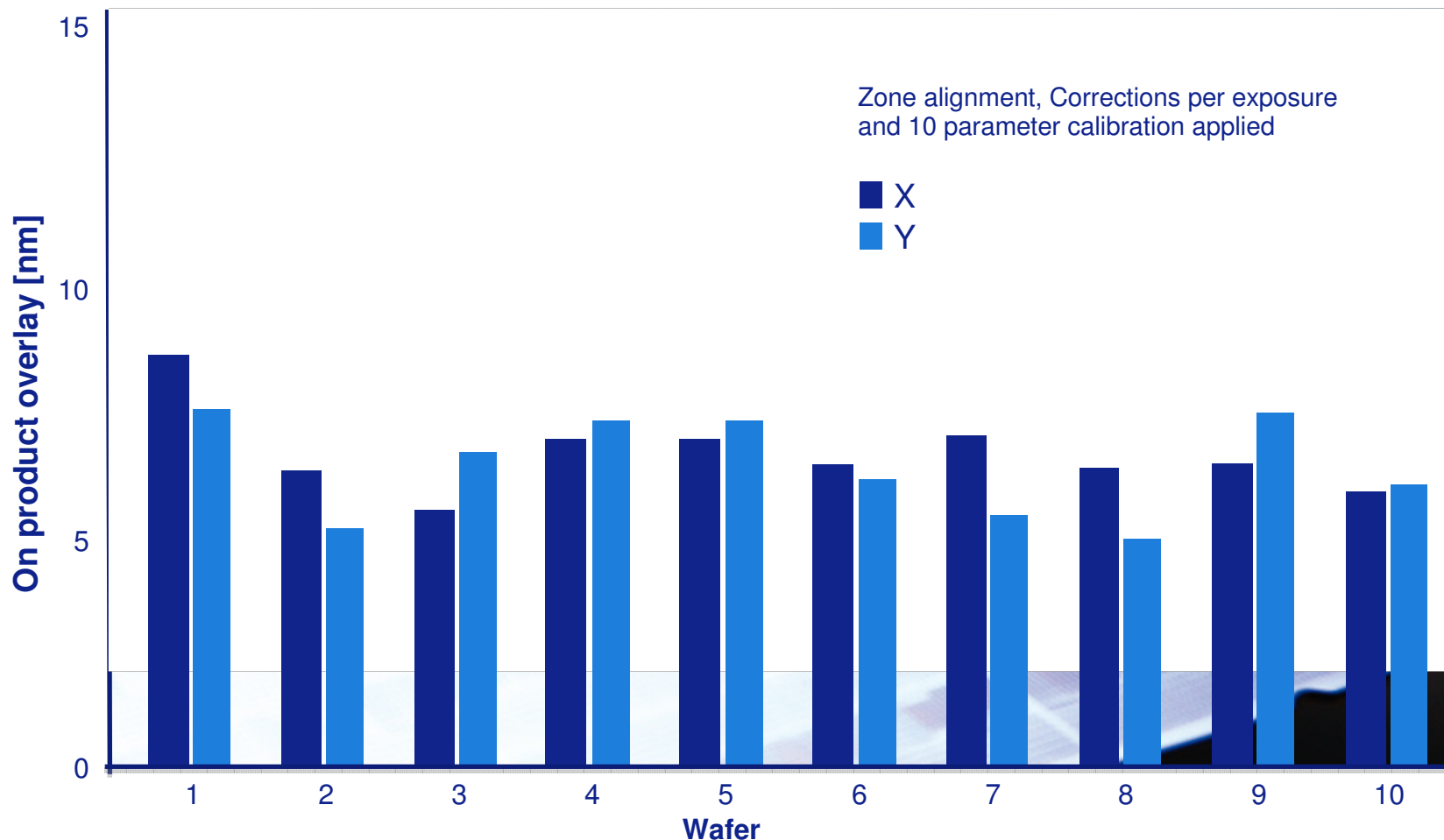
**Matched machine overlay [nm]
NXE:3100 matched to XT:1450 (Dry ArF)**



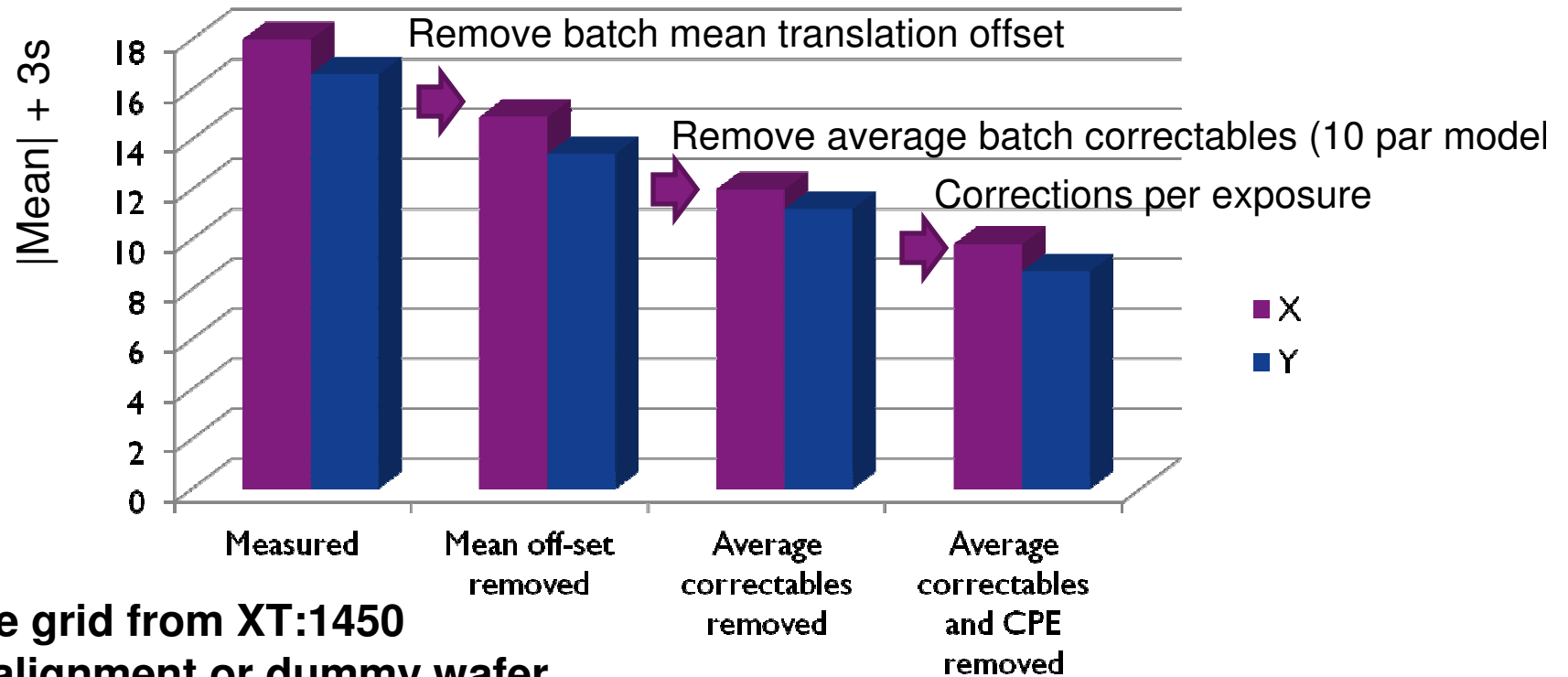
Dedicated chuck overlay of <1nm can be achieved on multiple NXE:3100 systems



Capability for 7nm on product overlay performance shown NXE:3100 matched to NXT:1950i (ArF immersion)



MODELING OF FIRST 5-WAFERLOT ON NXE:3100 - UNMATCHED



Reference grid from XT:1450
No zone alignment or dummy wafer
Dual chuck mode

Modeling of raw overlay data shows that corrections per exposure are needed for <10nm MMO vs. 1450 dry tool

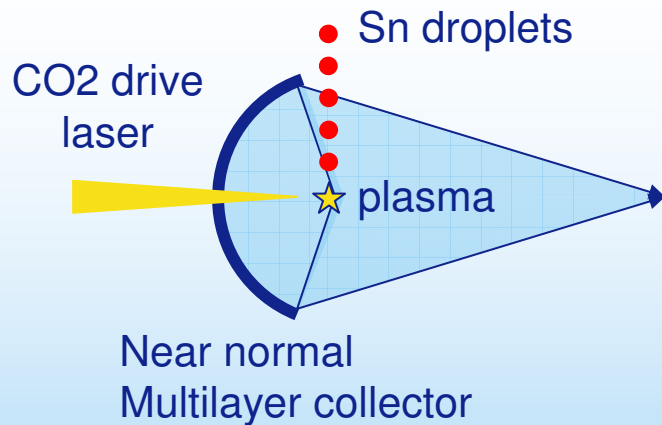
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Two EUV source concepts integrated and exposing

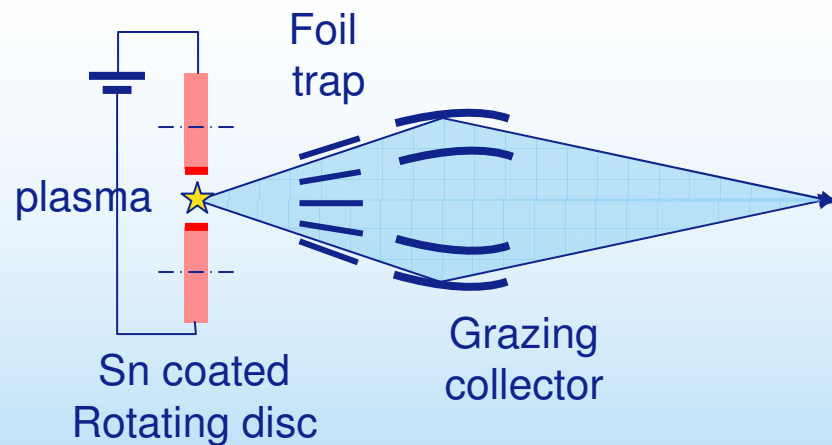
Laser-Produced Plasma (LPP)



- CO₂ laser ignites tin plasma
- Debris mitigation by background gas and possible magnetic field (Giga)

Suppliers: Cymer, Gigaphoton inc.

Electrical Discharge (LDP)



- High voltage ignites tin plasma
- Debris mitigation by rotating foil trap

Supplier: XTREME technologies GmbH

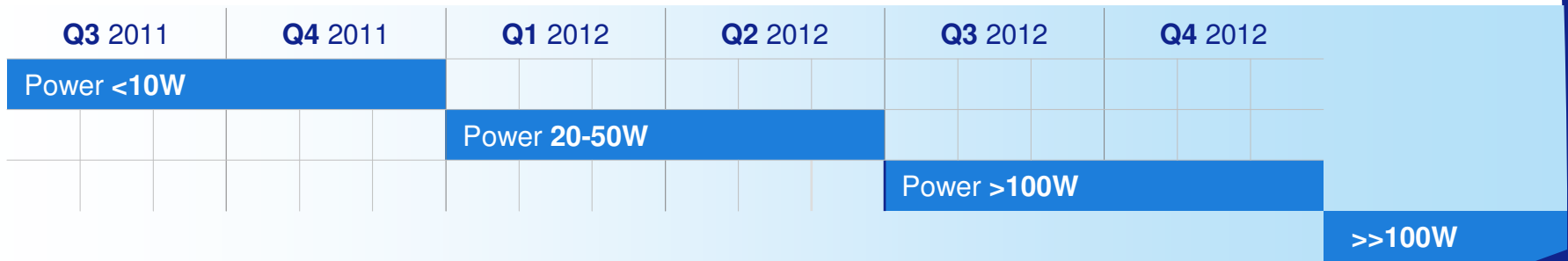
Presentation David Brandt (Cymer), Junichi Fujimoto (Gigaphoton Inc.), Marc Corthout (XTREME technologies GmbH)

October 17th

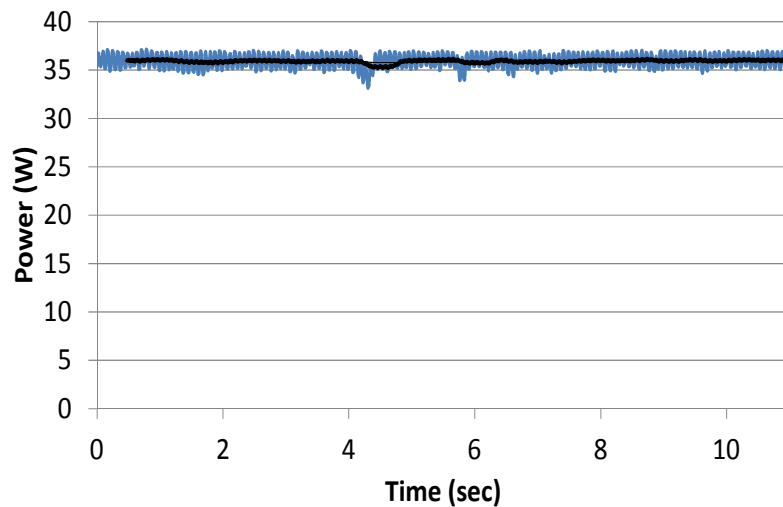
Slide 22 | Public



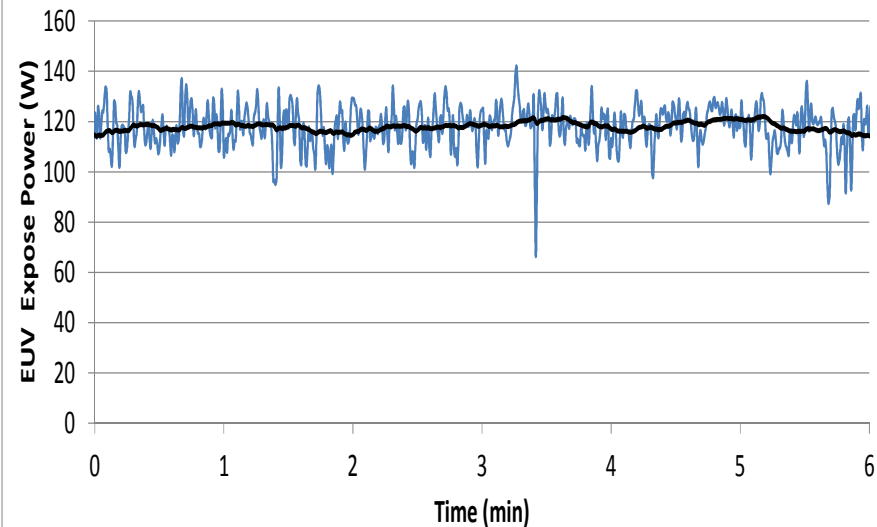
NXE Source power roadmap and LPP progress



- Expose power ~35W and 80% duty cycle
- Dose Stability $<\pm 0.5\%$
- Qualified and implementation according to roadmap



- Expose power >100W with Pre-Pulse
- Feasibility completed at low duty cycle, no dose control
- Full feasibility to be completed H2 '11 for implementation in H2 '12.



NXE Source power roadmap and LDP progress

Q3 2011			Q4 2011			Q1 2012			Q2 2012			Q3 2012			Q4 2012			
Power <10W																		
						Power 20-50W												
												Power >100W						
																	>>100W	

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NXE platform improving with NXE:3300B system

System performance	NXE:3300B
NA	0.33
Resolution (half-pitch)	22 nm (18 nm with OAI)
Overlay (DCO / MMO)	3.0 / 5.0 nm
Throughput	125 wph @ 15 mJ/cm ²

The NXE:3300B is a continuation of the NXE:3100 with

system common modules: stages, handlers, sensors, electronics & software

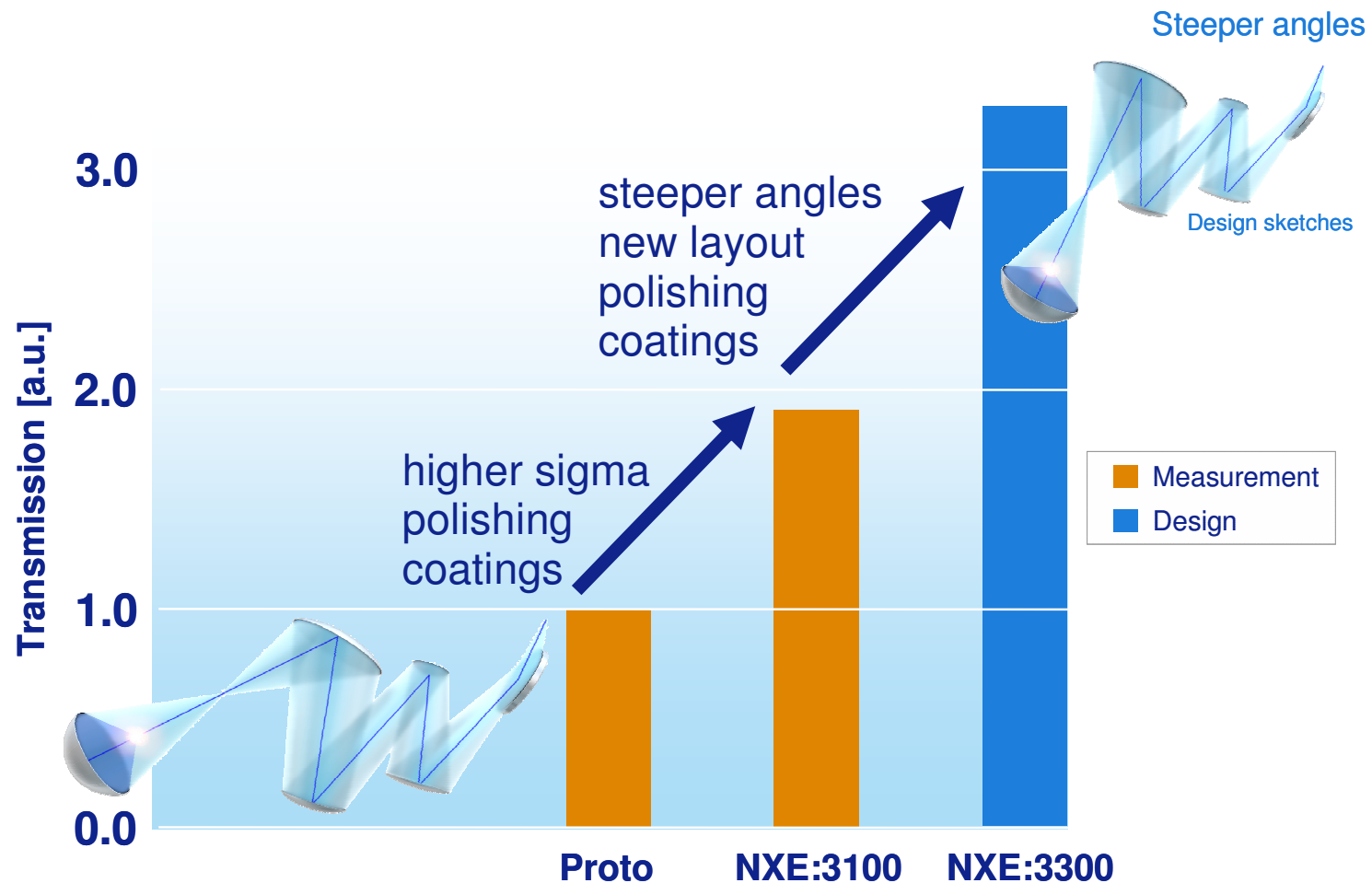
changed optical column: Improved resolution (0.33NA), increased transmission and capability for off-axis illumination without energy loss

reduced system and sub-fab footprint

First NXE:3300B body fully integrated and under vacuum

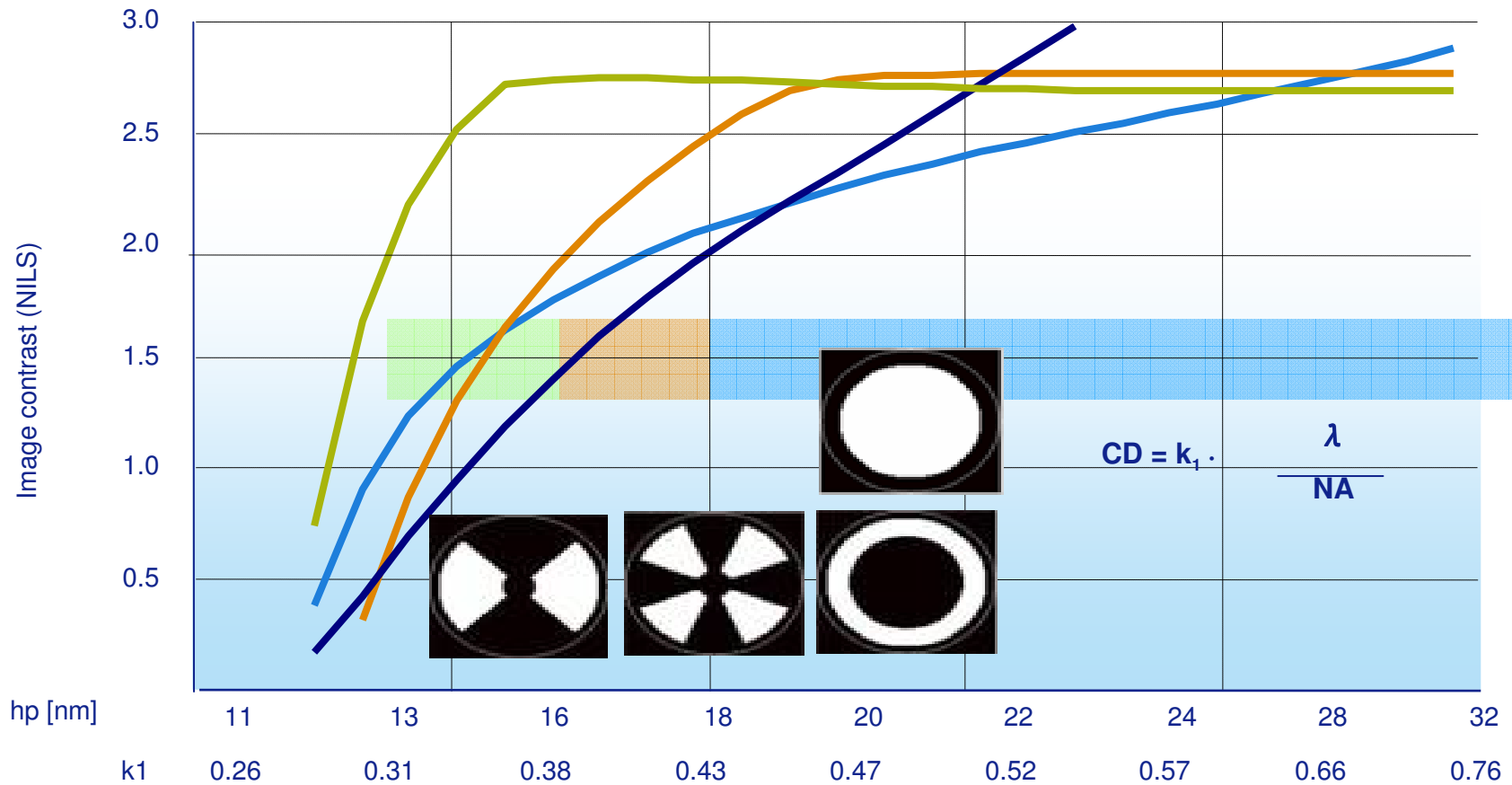


Higher NXE:3300B optics transmission increases throughput



Further resolution NXE:3300B extension with off-axis illumination without light loss

resolution extension below 16 nm



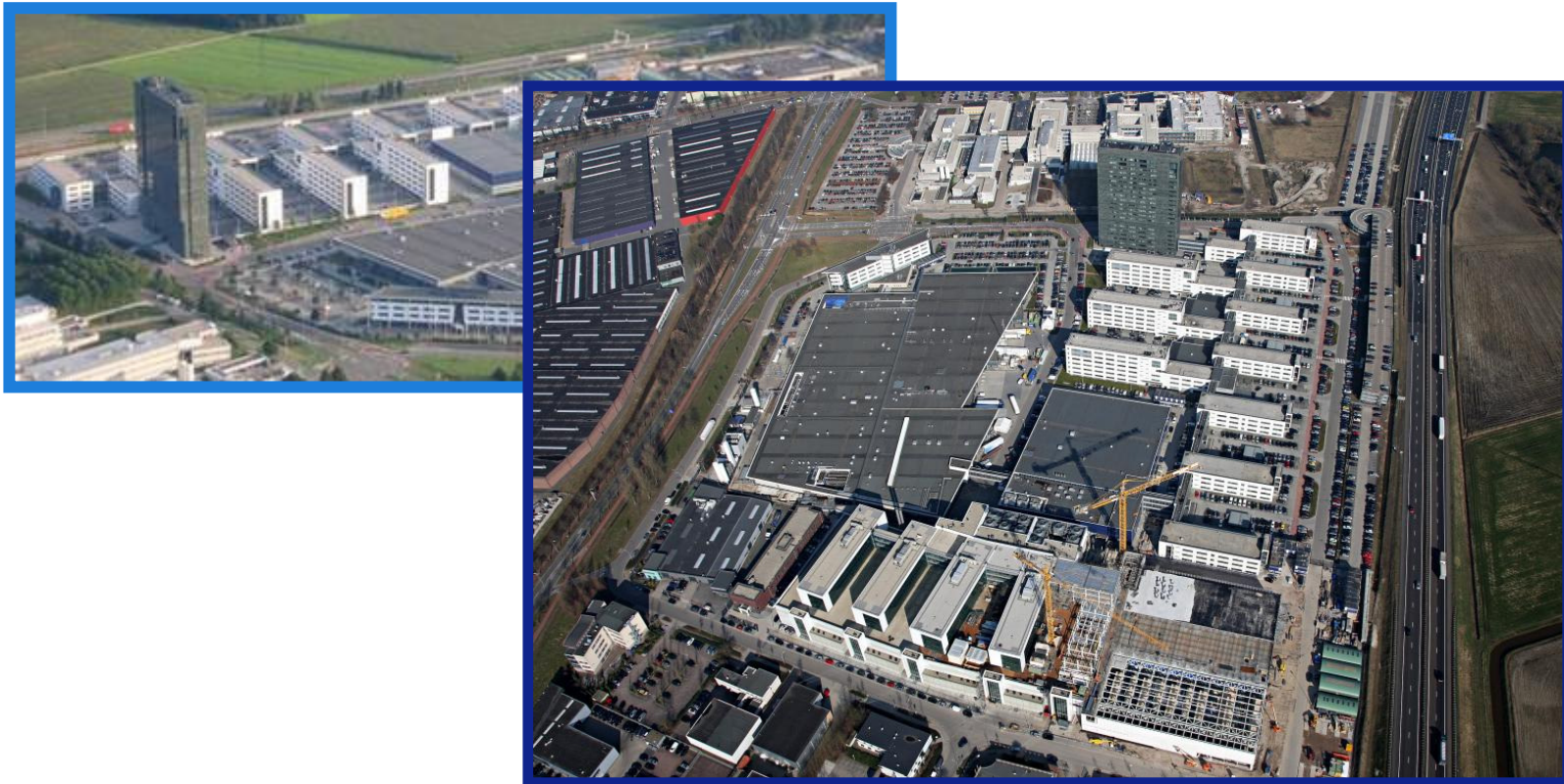
- Conventional
- Annular
- Quasar
- Dipole



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New EUV facilities will be available end 2011

NXE production capacity increases ~3x



*2 proto systems and 6 NXE:3100 shipped
10 customer commitments for NXE:3300B systems*

Acknowledgements

The work presented today, is the result of hard work and dedication of teams at ASML and many technology partners worldwide including our customers

ASML is grateful for the support by the Dutch Government of the EAGLE and EXEPT projects, as well as the MEDEA+ and CATRENE organizations of the European Union